

REMARKS

These amendment and remarks are filed in response to the Office Action mailed September 26, 2008. For the following reasons, this application should be allowed and the application passed to issue. No new matter is introduced by this amendment. The amendment to claim 5 is supported by Fig. 1 and the accompanying portions of the specification.

Claims 1-6 are pending in this application. Claims 1-4 were withdrawn pursuant to a restriction requirement. Claims 5 and 6 are rejected. Claim 5 is amended in this response.

Foreign Priority

The PTO-326 form did not acknowledge the claim for foreign priority or receipt of the Japanese priority document. It is requested that the Examiner acknowledge the claim for foreign priority and receipt of the foreign priority document in the next Official Action.

Claim Rejections Under 35 U.S.C. § 112

Claims 5 and 6 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite because it is allegedly not clear whether the hardenability values are before carbonitriding or after carbonitriding and before or after quenching. This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

The claims are definite to one of ordinary skill in this art. Claim 5 references JISG0561. JISG0561 is a Japanese Industrial Standard titled Method of Hardenability Test for Steel (End Quenching Method). The JIS clearly explains when and how hardenability is measured. For the Examiner's convenience, an English translation of JISG0561 is attached to this response. Thus, it would have been clear to one of ordinary skill in this art how and when hardenability is determined.

Claim Rejections Under 35 U.S.C. § 103

Claims 5 and 6 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Murakami et al. (US 5,413,643). The Examiner asserted that Murakami et al. disclose subjecting a rolling bearing to carbonitriding treatment at 870 °C to 890 °C wherein the rolling bearing comprises an inner ring, an outer ring, and rolling elements each composed of an alloy steel, containing carbon, silicon, manganese, and chromium. The Examiner averred that it would have been obvious to select the claimed carbonitriding temperatures and that the recited hardness would have been the same.

Claims 5 and 6 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ohki (US 2003/0123769). The Examiner noted that the claimed heat treating temperatures and steel composition overlapped those disclosed in Ohki. The Examiner asserted that the steel of Ohki would have the same hardness as claimed because it has the same composition and same carbonitriding process.

These rejections are traversed, and reconsideration and withdrawal thereof respectfully requested.

Murakami et al. and Ohki do not teach or suggest the claimed heat treatment for steel because neither Murakami et al. nor Ohki teach or suggest cooling the part to a temperature range lower than a transformation point A1 of said steel to provide a quenched part, tempering the quenched part; and subsequently heating the part again after tempering to a quenching temperature range not lower than the transformation point A1 and lower than a temperature used for said carbonitriding or nitriding, as required by claim 5. Neither Murakami et al. nor Ohki suggest the tempering step, as required by claim 5. The tempering step between the first and

second quenching steps suppresses season cracking after the first quenching step. This benefit is not suggested by the cited references.

Obviousness can be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either explicitly or implicitly in the references themselves or in the knowledge readily available to one of ordinary skill in the art. *In re Kahn*, 441 F.3d 977, 986, 78 USPQ2d 1329, 1335 (Fed. Cir. 22006); *In re Kotzab*, 217 F.3d 1365, 1370 55 USPQ2d 1313, 1317 (Fed. Cir. 2000); *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). There is no suggestion in Murakami et al. and Ohki to modify the methods of Murakami et al. and Ohki to include a tempering step, as required by claim 5, nor does common sense dictate the Office-asserted modification. *See KSR Int'l Co. v. Teleflex, Inc.*, 500 U.S. ____ (No. 04-1350, April 30, 2007) at 20.

The only teaching of the claimed heat treatment method is found in Applicant's disclosure. However, the teaching or suggestion to make a claimed combination and the reasonable expectation of success must not be based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

Dependent claim 6 is allowable for at least the same reasons as claim 5, and further distinguish the claimed heat treatment method.

In view of the above remarks, Applicant submits that this application should be allowed and the case passed to issue. If there are any questions regarding this response or the application in general, a telephone call to the undersigned would be appreciated to expedite the prosecution of the application.

Application No.: 10/586,299

To the extent necessary, a petition for an extension of time under 37 C.F.R. § 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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JIS

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS G 0561 : 1998

**Method of hardenability test for steel
(End quenching method)**

ICS 77.040.99

Descriptors : steels, ferrous metals, ferrous alloys, hardenability, mechanical properties of materials, heat treatment, jominy tests, hardness testing, work-hardening

Reference number : JIS G 0561 : 1998 (E)

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS G 0561:1983** is replaced with **JIS G 0561:1998**.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Date of Establishment: 1956-01-19

Date of Revision: 1998-12-20

Date of Public Notice in Official Gazette: 1998-12-21

Investigated by: Japanese Industrial Standards Committee
Divisional Council on Iron and Steel

JIS G 0561:1998, First English edition published in 1999-07

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

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the original JIS is to be the final authority.

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JAPANESE INDUSTRIAL STANDARD

JIS G 0561 : 1998

Method of hardenability test for steel (End quenching method)

Introduction This Japanese Industrial Standard is established for standardization of Hardenability band of steel in 1956, reconsidering is executed placing principal points on achievement of coordination with ISO as far as possible in revision in 1983, and the Standard has come to today's state.

Though 15 years have passed since the last revision, since coordination with the corresponding International Standard ISO 642 : 1979, *Steel—Hardenability test by end quenching (Jominy test)* is required to be achieved, this revision is executed.

Principal revised points are as follows.

- a) A test piece with an under-cut is specified.
- b) Method for measurement in hardness of low hardenability steel is specified.
- c) For presentation of hardenability index, ISO/DIS 642 :1996 is authorized, and the presentation in JIS is specified with a time limit.
- d) Coordination with JIS Z 8301 *Rules for the drafting and presentation of Japanese Industrial Standards*.

1 Scope This Japanese Industrial Standard specifies the method of hardenability test for steel based on Jominy's end quenching method.

Remarks: The corresponding International Standard to this Standard is given as follows.

ISO 642 :1979 *Steel—Hardenability test by end quenching (Jominy test)*

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards indicated below shall be applied.

JIS G 0202 *Glossary of terms used in iron and steel (testing)*

JIS G 0551 *Methods of austenite grain size determination for steel*

JIS G 4202 *Aluminium chromium molybdenum steels*

JIS G 4801 *Spring steels*

JIS Z 2244 *Vickers hardness test-Test method*

JIS Z 2245 *Rockwell hardness test — Test method*

3 Definitions For the main terms used in this Standard, the definitions in JIS G 0202 apply, and the rest of the terms shall be as given in Table 1.

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Table 1 Symbols and designations

Symbol	Designation	Value
L	Total length of test piece	100 mm \pm 0.5 mm
D	Diameter of test piece	25 mm \pm $^{0.5}_0$ mm
t	Time during which test piece is maintained at heating temperature	30 min \pm 5 min
t_m	Maximum time lag between removal of test piece from furnace and start of quenching	5 s
T	Temperature of cooling water	5 °C to 30 °C
a	Internal diameter of vertical water supply pipe	12.5 mm \pm 0.5 mm
h	Height of water jet without test piece in position	65 mm \pm 10 mm
l	Distance from end of water supply pipe to lower end of test piece	12.5 mm \pm 0.5 mm
e	Depth of flats for measurement of hardness	0.4 mm to 0.5 mm
d	Distance, in millimeters, from quenched end to points where hardness is measured	
$Jd=xx$	Jominy hardenability index at distance d , in Rockwell HRC-mm	
$Jd=xxHV$	Jominy hardenability index at distance d , in Vickers HV 30-mm	

4 Principle The test consists in :

heating a cylindrical test piece to a specified temperature in the austenitic range for a specified period of time;

quenching it by spraying water on one of its ends;

measuring the hardness either between two selected points or at certain given points, on longitudinal flats made on the test piece, in order to determine the hardenability of the steel by variations of this hardness.

5 Apparatus for quenching The apparatus for quenching shall be as follows.

5.1 Support for test piece The support for test piece shall be as follows.

- The support for test piece with a flange shall be as given in Fig. 1, the test piece is vertically installed, and its lower end to be quenched shall position rightly 12.5 mm \pm 5 mm above the orifice.
- For the support for test piece with undercut, the appropriate support means capable of installing the test piece at an accurate position in a moment shall be used.

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Unit : mm

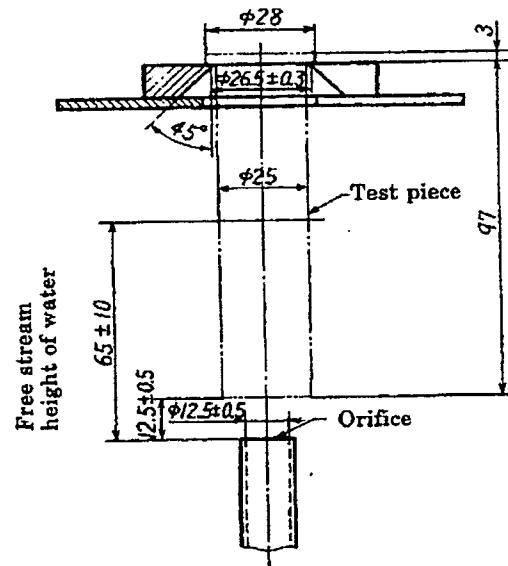


Fig. 1 Apparatus for quenching

5.2 Apparatus for cooling spray The apparatus shall be able to make water to spout up from the mouth of the pipe of $12.5 \text{ mm} \pm 0.5 \text{ mm}$ inside diameter to the free height of $65 \text{ mm} \pm 10 \text{ mm}$.

The stream of water shall be controlled to attain the specified free height immediately after the commencement of water cooling, and the free stream height shall be kept steady during the cooling process. For this purpose, the tank with the overflow apparatus shall be used, and the plate may be preferably inserted between the test piece and the orifice as the stopping device for stream of water.

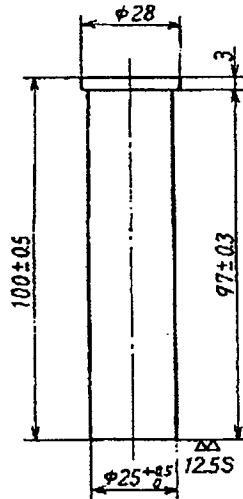
6 Test piece

6.1 Dimension of test piece Dimension of the test piece shall be as shown in Fig. 2, and its selection shall be subjected to the material standard.

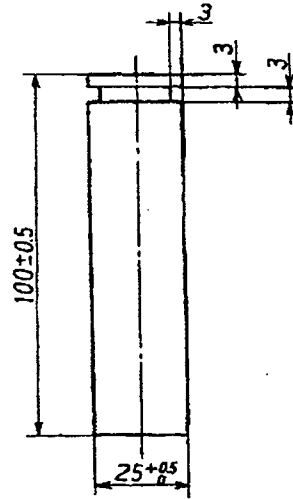
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Unit: mm



Test piece with flange



Test piece with undercut

Fig. 2 Dimension of test piece

6.2 Preparation of test method The preparation of a test piece shall be as follows.

- When the steel material is from 30 mm to 32 mm in diameter, the test specimen shall be used as it is. For steel material more than 32 mm in diameter, the test specimen shall be forged or rolled to 30 mm in diameter.
- Unless otherwise specified, the test specimen thus obtained shall be normalized for 60 min at a temperature as shown in Table 2, the decarburized layer shall be removed from the surface, which is finished to the specified dimensions. The end of the specimen to be water cooled shall be precisely finished. The normalizing of the test specimen may be omitted subjected to the agreement.
- In the case where heat treatment other than normalizing is applied to the test specimen and in the case where heat treatment is applied to the test piece, the heat treatment career shall be recorded and reported.

Table 2 Normalizing and quenching temperatures for test specimen or test piece

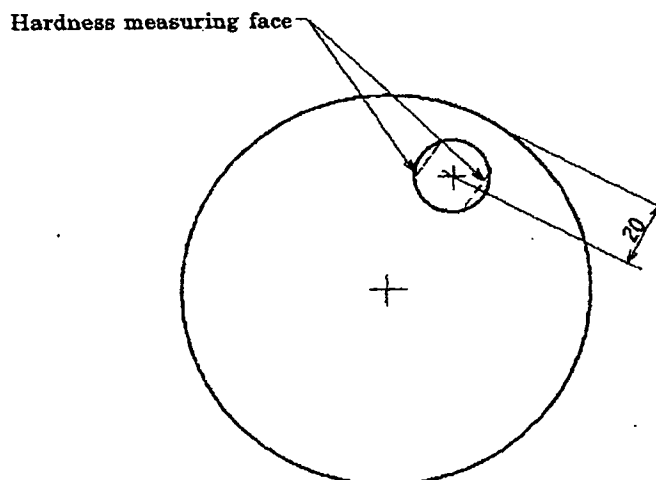
Specified value or the maximum value of chemical composition		Normalizing temperature	Quenching temperature
Ni %	C %	℃	℃
Up to and incl. 3.00	Up to and incl. 0.25	925	925
	0.26 and over, up to and incl. 0.36	900	870
	0.37 and over	870	845

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G 0561 : 1998**Table 2 (concluded)**

Specified value or the maximum value of chemical composition		Normalizing temperature	Quenching temperature
Ni %	C %	℃	℃
Over 3.00	Up to and incl. 0.25	925	845
	0.26 and over, up to and incl. 0.36	900	815
	0.37 and over	870	800
SUP6, SUP7, SUP9, SUP9A, SUP10, SUP11A of JIS G 4801		900	870
JIS G 4202		980	925

Remarks: Tolerance on temperatures mentioned above shall be ± 5 °C.

- d) In the case where the diameter of steel is over 32 mm, when agreed, a 30 mm test specimen may be machined out by omitting forging or rolling. After normalizing in the same way as in b), the test piece of a specified size may be machined out, or the specified size test piece may be machined out directly from the steel material. However, in order to measure the hardness at the position equal distance from the center of steel material of the base specified in 8.1 (see Fig. 3), in any case thereof, the position of the test specimen (or the test piece) in the steel material shall be apparently indicated.

**Fig. 3 Example of sampling by machining of the test piece**

- e) When especially agreed, the test sample may be prepared by casting.

7 Quenching method

7.1 Heating method The heating method shall be as follows.

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- a) The test piece shall be heated in a furnace being kept at a temperature given in the Table 2, and heated to be of uniform temperature from the surface to the center, then kept at the temperature for $30 \text{ min} \pm 5 \text{ min}$. By agreement, other quenching temperatures may be applied.
- b) The minimum necessary heating time shall be predetermined on the basis of the result of previous temperature measurement using a thermocouple buried in the center part of the test piece.
- c) An adequate method ⁽¹⁾ shall be applied at the time of heating in order that the end of the test piece may be left free from scale, and that it may prevent oxidation and decarburization to such an extent that the decarburized layer beneath the surface to be measured may be completely removed by grinding.

Note ⁽¹⁾ For example, application of a protective gas, embedment of the end to be quenched in graphite or chips of cast iron, or application of a special heat resisting steel cap onto the end.

7.2 Quenching procedure The quenching procedure shall be as follows.

- a) The test piece heated to a quenching temperature shall be installed vertically on the support, stopping device for stream of water shall be opened immediately thereafter, and then the test piece shall be cooled for 10 min at least till it cools completely. Afterwards, the test piece may be cooled in water.
- b) The support for the test piece shall not be wet when the quenching starts.
- c) The time between extraction of the test piece from the heating furnace and the beginning of the quenching shall be as short as possible so that the time will not exceed 5 s.

7.3 Quenching medium Water at a temperature of 5°C to 30°C shall be used as quenching medium.

8 Measuring method of hardness

8.1 Hardness test piece The hardness test piece shall be as follows.

- a) After being cooled, the test piece shall be ground at 2 positions 180° apart to remove 0.4 mm to 0.5 mm each in thickness along its overall length, and 2 planes thus obtained shall be subjected to hardness measurement.
- b) For the test piece machining directly from the steel material with more than 32 mm in diameter, the hardness measurement shall, in general, be made to planes equally distant from the axis of original steel material.

Remarks: On grinding the test piece, care shall be taken to prevent any structural change being caused by the grinding heat. Structural change caused by grinding shall be detected as follows:

1) Etching reagent

First reagent Nitric acid (specific gravity 1.42)
5 % + water 95 %

Second reagent Hydrochloric acid (specific gravity 1.18)
50 % + water 50 %

- 2) **Procedure** After being washed with hot water, the test piece shall be etched with the first reagent till the reagent changes black in color, for about 30 s to 60 s. It is then rinsed with hot water, and dipped in a second reagent for 3 s. It is rinsed again with hot water and lightly blow-dried for detection. The presence of spots on the etched surface indicates that the structure has been changed during grinding. The changed structure caused by grinding shall be removed before starting the measurement of the hardness. For this purpose, refinishing and reetching should be applied, but, when the structural change is too conspicuous, fresh test planes shall be prepared for hardness measurement.

8.2 Hardness measuring point The hardness measuring point shall be as follows.

- a) Hardness measuring points shall be 1.5 mm or more apart from the quenched end, and selection of actual measuring points shall be as appropriate.
- b) For drawing of the hardenability curve, measuring points shall, in general, position at 1.5-3-5-7-9-11-13-15 mm from the quenched end and at 5 mm intervals thereafter.
- c) In the case where a hardenability curve is drawn concerning to low hardenable steel specified in the material standard, the initial measuring point is 1.0 mm from the quenched end, and from the next point to 11 mm from the quenched end, 1.0 mm interval is provided. The last five points are those 13-15-20-25-30 mm apart from the quenched end.

8.3 Measurement of hardness The measurement of hardness shall be as follows.

- a) Hardness measurement may be commenced from either side, the quenched end or the opposite side.
- b) For hardness measurement, Rockwell C hardness or Vickers hardness shall be numbered. The measurement of Rockwell C hardness and Vickers hardness shall consult JIS Z 2245 and JIS Z 2244, respectively, in addition to the specification of 8.2.

Remarks: For hardness measurement, appropriate test base should be used to hold correct measuring points successively and to save testing time. V block is inadequate for application because it will easily incline the test piece. When the reverse side of the already used test plane is subjected to measurement, care should be taken that the current measurement may not be affected by the indentations made by prior tests.

9 Record Mean values of hardnesses measured at corresponding points on both test planes of the test piece shall be obtained and the hardness transfer along axis direction shall be plotted in Hardenability Chart (2) shown in Annex (informative).

Ordinate of the chart shows the mean value of measured hardness of corresponding points and abscissa the distance measured from the quenched end to the measuring points.

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In addition, steel charge number, austenite grain size (grain number and measuring method), chemical composition, heat treatment temperature, sampling position of the test piece, water temperature and other special heat treatment details shall be recorded.

Note (2) In the Hardenability Chart, either Rockwell hardness C scale or Vickers hardness scale may be omitted, and ordinate per abscissa ratio shall be 2 : 3.

Remarks: For the presentation of hardenability, Hardenability Chart or Hardenability Index shall be used. Hardenability Index shall be indicated by the hardness at a point of a predetermined distance apart from the quenched end, or by the distance measured from the quenched end to a point having a predetermined hardness to 2003 year in steel. For hardenability presentation by Hardenability Index, the hardness notation may be omitted, when measured in Rockwell hardness, as shown in the following examples:

Example 1 When the hardness of the point 12 mm apart from the quenched end is 36HRC or 354HV, it is expressed as:

J 12 mm 36HRC, J 12 mm 36 or

J 12 mm 354HV

Example 2 When the point having hardness of 45HRC or 446HV is 6 mm apart from the quenched end, it is expressed as:

J45HRC = 6 mm, J 45 = 6 mm or

J446HV = 6 mm

10 Report In the case where a test report is required, the following items shall be selected as report items subjected to the agreements between the parties concerned.

- a) Reference to this Standard
- b) Grade of material
- c) Cast number
- d) Chemical composition
- e) Method of sampling
- f) Conditions for the normalizing treatment and the heating of the test piece
- g) The hardness testing method
- h) Test result

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Annex (informative) Hardenability Chart

Testing date (Year) (Month) (Day)

Testing place

Tester's name

Kind of steel	Charge number	Austenite grain size number	Chemical composition %											Heat treatment temperature °C		Water temp. °C
			C	Si	Mn	P	S	Ni	Cr	Mo	Cu			Normalizing temp.	Quenching temp.	

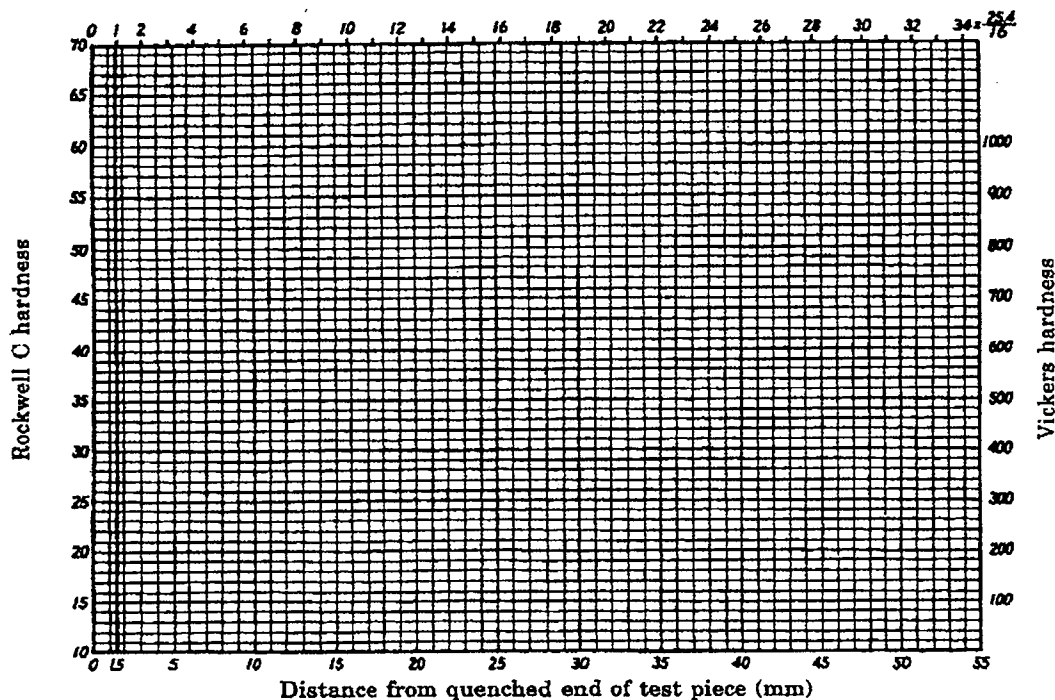
Remarks: (Special heat treatment record, sampling position of test piece, and others)

Method of austenite grain size test (by indication following JIS G 0551)

Hardness test machine (either one shall be marked off)

Rockwell

Vickers



- Remarks 1 No relation exists between the scales of Rockwell C hardness and Vickers hardness.
- 2 One of the hardness scales that is unused shall be marked off.

Errata for JIS (English edition) are printed in *Standardization Journal*, published monthly by the Japanese Standards Association, and also provided to subscribers of JIS (English edition) in *Monthly Information*.

Errata will be provided upon request, please contact:
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